REMARKS

Applicant respectfully traverses the 35 U.S.C. § 112, second paragraph rejection of claims 1-10. The term "rigidity" encompasses the commonly understood definition of the term, and Applicant is not required to set forth specific values or units of measurement. Claims 1 and 2 recite rigidity in terms of comparative values, between different components of the claimed exhaust heat power generation apparatus, in a format that would be understood by a person of ordinary skill in the art. For example, M. Lindeburg *Mechanical Engineering Reference Manual for the PE Exam* (1998) pages 49-2, 49-3 (attached) discloses: "Rigidities have no units, and the individual rigidity values have no significance. A ratio of two rigidities, however, indicates how much stronger one member is compared to another." In view of the teaching of this learned treatise, the comparative restriction of rigidity, as recited in claims 1 and 2, is definite under 35 U.S.C. §112, second paragraph. Claims 3-10 depend from claims 1 and 2 and are definite for the same reason.

Applicant respectfully traverses the 35 U.S.C. § 103(a) rejection of claims 1-4 and 8-10 over Katsumi (JP H11-122960); and the § 103(a) rejection of claims 5-7 over Katsumi in view of Kazuhiko (JP H11-036981). Claim 1 recites, "a cooling unit provided on the other surface of the thermoelectric converting unit." Katsumi and Kazuhiko fail to disclose or suggest, alone or in combination, at least this aspect of claim 1, and at least for the reason fail to establish a *prima facie* case of obviousness. *See* M.P.E.P. § 2143.03.

Katsumi discloses a "heat release surface 13a," (Katsumi [0045]), which the Examiner alleges is analogous to the cooling unit disclosed in claim 1. *See* Office Action at page 4. Katsumi further discloses a "[a] buffer member 35 provided between a heat release surface 13a... [and] surface 33b of a thermoelectric conversion module 33." Katsumi [0045]. Therefore, even assuming that the Examiner is correct, which Applicant does not concede, Katsumi teaches away from providing the cooling unit "on the other surface of the thermoelectric converting unit," as recited in claim 1. In addition, as recited in new claim 16, the cooling unit contacts the heat exchange unit, which is contrary to the teachings of Katsumi.

Kazuhiko does not cure the shortcomings of Katsumi noted above in connection with claim 1. Katsumi and Kazuhiko, alone or in combination, therefore, do not suggest all of the elements of claim 1, and hence no *prima facie* case of obviousness has been established. Claims 2-10 depend on claim 1 and are allowable for at least the same reasons.

Notwithstanding the fact that no *prima facie* case of obviousness has been established, Applicant submits that it also would not be obvious to one of ordinary skill in the art to modify the rigidity of components in Katsumi as recited in the Office Action. *See* Office Action at page 4. As recited, *e.g.,* in claim 1, an exhaust heat power generation apparatus comprises a thermoelectric converting unit having a first value of rigidity, a heat exchange unit having a second value of rigidity, and a cooling unit having a third value of rigidity. The third value of rigidity of the cooling unit is higher than the first and second values of rigidity of the thermoelectric converting unit and the heat exchange unit, respectively.

Katsumi neither discloses nor suggests different values of rigidity for different components, and particularly does not disclose or suggest that a value of rigidity of a cooling unit is higher than respective values of rigidity of a thermoelectric converting unit and a heat exchange unit. Katsumi only discloses that a heat exchange unit can be manufactured from a number of metals. *See* Katsumi at [0063]. Applicant submits that the modification to Katsumi proposed in the Office Action is inappropriate because Katsumi does not suggest that rigidity is a result effective variable. According to the M.P.E.P., only parameters that are recognized as result-effective may be optimized. *See* M.P.E.P. § 2144.05. Katsumi does not disclose or suggest selection of material based on rigidity, let alone recognize the value of designing a cooling unit with a higher rigidity than that of the thermoelectric converting unit and the heat exchange unit; therefore it cannot be obvious to optimize the relative rigidity values of components in Katsumi.

Applicant has added new claim 16, to round out the coverage to which it is entitled.

In view of the above amendments and remarks, Applicant respectfully requests reconsideration and allowance of claims 1-10 and 16.

Entry of the Amendment After Final Action is proper under 37 C.F.R. §1.116 in order to place the claims in condition for allowance, or in better from for appeal, and to give the Applicant the opportunity to submit the cited learned treatise, in response to the Examiner's improper § 112, second paragraph rejection

Please enter the amendment, grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

Dated: December 17, 2008

By: [signature]
Kathryn Erklauer
Reg. No. 31,339

Enclosures: M. Lindeburg *Mechanical Engineering Reference Manual for the PE Exam* (1998) pages 49-2, 49-3.

English translation of JP11-122960, paragraphs [0045] - [0063], (cited in PTO/SB/08 filed June 27, 2005).

1. BASIC CONCEPTS

Strength of materials (known also as *mechanics of materials*) deals with the elastic behavior of loaded engineering materials.[1] This subject draws heavily on the topics in Chaps. 46 and 48.

Stress is force per unit area, F/A. Typical units of stress are lbf/in^2, ksi (thousands of pounds per square inch), and MPa. Although there are many names given to stress, there are only two primary types, differing in the orientation of the loaded area. With *normal stress*, σ, the area is normal to the force carried. With *shear stress*, τ, the area is parallel to the force.

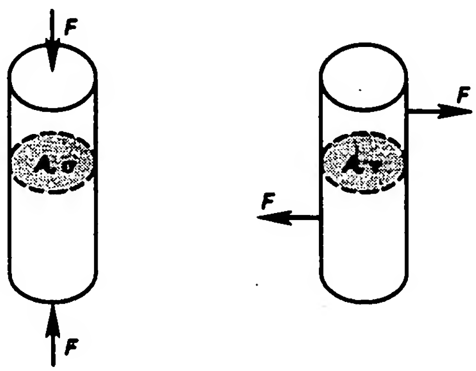


Figure 49.1 Normal and Shear Stress

Strain, ϵ, is elongation expressed on a fractional or percentage basis. It may be listed as having units of in/in, mm/mm, and percent, or no units at all. A strain in one direction will be accompanied by strains in orthogonal directions in accordance with Poisson's ratio. *Dilation* is the sum of the strains in the three coordinate directions.

$$\text{dilation} = \epsilon_x + \epsilon_y + \epsilon_z \qquad 49.1$$

2. HOOKE'S LAW

Hooke's law is a simple mathematical statement of the relationship between elastic stress and strain: Stress is proportional to strain. For normal stress, the constant of proportionality is the *modulus of elasticity* (*Young's modulus*), E.

$$\sigma = E\epsilon \qquad 49.2$$

For shear stress, the constant of proportionality is the *shear modulus*, G.

$$\tau = G\phi \qquad 49.3$$

[1] Plastic behavior and ultimate strength design are not covered in this book.

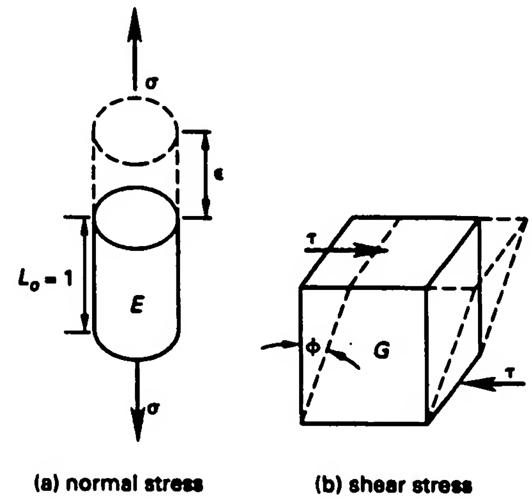


Figure 49.2 Application of Hooke's Law

3. ELASTIC DEFORMATION

Since stress is F/A and strain is δ/L_o, Hooke's law can be rearranged in form to give the elongation of an axially loaded member with a uniform cross section experiencing normal stress. Tension loading is considered positive; compressive loading is negative.

$$\delta = L_o\epsilon = \frac{L_o\sigma}{E} = \frac{L_oF}{EA} \qquad 49.4$$

The actual length of a member under loading is given by Eq. 49.5. The algebraic sign of the deformation must be observed.

$$L = L_o + \delta \qquad 49.5$$

4. TOTAL STRAIN ENERGY

The energy stored in a loaded member is equal to the work required to deform the member. Below the proportionality limit, the total *strain energy* for a member loaded in tension or compression is given by Eq. 49.6.

$$U = \tfrac{1}{2}F\delta = \frac{F^2L_o}{2AE} = \frac{\sigma^2L_oA}{2E} \qquad 49.6$$

5. STIFFNESS AND RIGIDITY

Stiffness is the amount of force required to cause a unit of deformation (displacement) and is often referred to as a *spring constant*. Typical units are pounds per inch and newtons per meter. The stiffness of a spring or other structure can be calculated from the deformation equation by solving for F/δ. Equation 49.7 is valid for tensile and compressive normal stresses. For torsion and bending, the stiffness equation will depend on how the deflection is calculated.

$$k = \frac{F}{\delta} \quad \text{[general form]} \qquad 49.7(a)$$

$$= \frac{AE}{L_o} \quad \text{[normal stress form]} \qquad 49.7(b)$$

When more than one spring or resisting member share the load, the relative stiffnesses are known as *rigidities*. Rigidities have no units, and the individual rigidity values have no significance. A ratio of two rigidities, however, indicates how much stronger one member is compared to another. Equation 49.8 is one method of calculating rigidity in a multi-member structure. (Since rigidities are relative numbers, they can be multiplied by the least common denominator to obtain integer values.)

$$R_j = \frac{k_j}{\sum_i k_i} \qquad \textit{49.8}$$

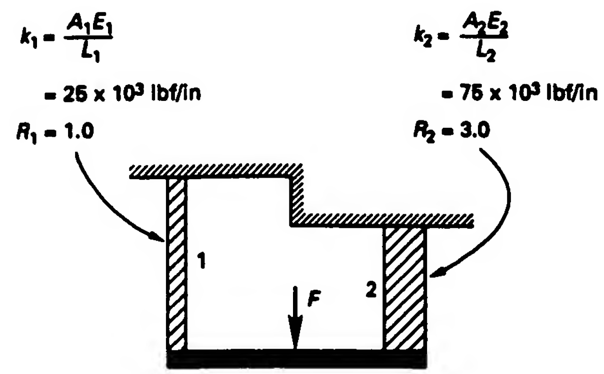


Figure 49.3 Stiffness and Rigidity

Rigidity is the reciprocal of deflection. *Flexural rigidity* is the reciprocal of deflection in members that are acted upon by a moment (i.e., are in bending), although that term may also be used to refer to the product, EI, of the modulus of elasticity and the moment of inertia.

6. THERMAL DEFORMATION

If the temperature of an object is changed, the object will experience length, area, and volume changes. The magnitude of these changes will depend on the *coefficient of linear expansion*, α, which is widely tabulated for solids. *The coefficient of volumetric expansion*, β, is encountered less often for solids but is used extensively with liquids and gases.

$$\Delta L = \alpha L_o(T_2 - T_1) \qquad \textit{49.9}$$

$$\Delta A = \gamma A_o(T_2 - T_1) \qquad \textit{49.10}$$

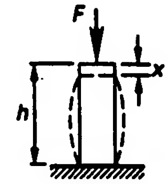
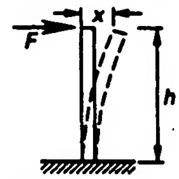
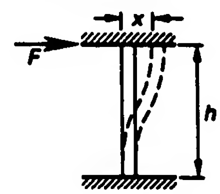
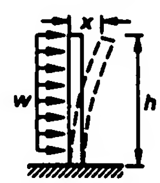
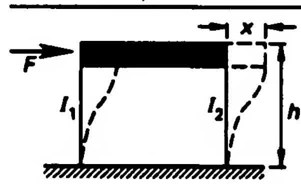
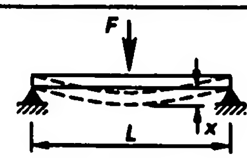
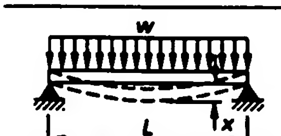
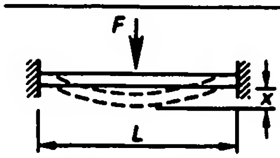
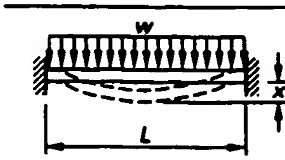
$$\gamma \approx 2\alpha \qquad \textit{49.11}$$

$$\Delta V = \beta V_o(T_2 - T_1) \qquad \textit{49.12}$$

$$\beta \approx 3\alpha \qquad \textit{49.13}$$

It is a common misconception that a hole in a plate will decrease in size when the plate is heated (because the surrounding material "squeezes in" on the hole). However, changes in temperature affect all dimensions the same way. In this case, the circumference of the hole is a linear dimension that follows Eq. 49.9. As the circumference increases, the hole area also increases.

Table 49.1 Deflection and Stiffness for Various Systems (due to bending moment alone)

system	maximum deflection (x)	stiffness (k)
	$\frac{Fh}{AE}$	$\frac{AE}{h}$
	$\frac{Fh^3}{3EI}$	$\frac{3EI}{h^3}$
	$\frac{Fh^3}{12EI}$	$\frac{12EI}{h^3}$
	$\frac{wL^4}{8EI}$	$\frac{8EI}{L^3}$
	$\frac{Fh^3}{12E(I_1+I_2)}$	$\frac{12E(I_1+I_2)}{h^3}$
	$\frac{FL^3}{48EI}$	$\frac{48EI}{L^3}$
 (w is load per unit length)	$\frac{5wL^4}{384EI}$	$\frac{384EI}{5L^3}$
	$\frac{FL^3}{192EI}$	$\frac{192EI}{L^3}$
 (w is load per unit length)	$\frac{wL^4}{384EI}$	$\frac{384EI}{L^3}$

[0045] A buffer member 35 is provided between a heat release surface 13a of an outer cylinder 11 and a low-temperature end surface 33b of a thermoelectric conversion module 33. The buffer member 35 has excellent heat transference, and appropriate flexibility. When the thermoelectric conversion module 33 is pressed to a heat collection surface 19a of an inner shell 19, the buffer member 35 has a function of buffering mechanical vibration, and a function of buffering thermal shock given to a high-temperature end surface 33a of the thermoelectric conversion module 33 by a change in the temperature of the inner shell 19 caused by a sharp change in the temperature of exhaust gas or the flow rate of the exhaust gas.

[0046] In the above-described exhaust heat power generation apparatus, exhaust gas G, which flows into an exhaust gas inlet 19b of the inner shell 19 from an exhaust pipe, is diffused along the heat collection surface 19a, and then, the exhaust heat of the exhaust gas G is collected by a heat collection fin 21 of the inner shell 19. The exhaust heat is transferred to the high-temperature end surface 33a of the thermoelectric conversion module 33 via the heat collection surface 19a. Thus, the high-temperature end surface 33a of the thermoelectric conversion module 33 is heated.

[0047] At the same time, the heat of the low-temperature end surface 33b of the thermoelectric conversion module 33 is released to the outside of the outer cylinder 11 from a heat release fin 13g to which wind is blown when a vehicle travels, via an upper outer shell 13A, and a heat release surface 13a of a lower outer shell 13B. Thus, the low-temperature end surface 33b of the thermoelectric conversion module 33 is cooled. Then, a thermal electromotive force is generated in the thermoelectric conversion module 33 according to a thermal gradient between the high-temperature end surface 33a and the low-temperature end surface 33b in the thermoelectric conversion module 33. Thus, electric power is generated.

[0048] Also, the low-temperature end surface 33b of the thermoelectric conversion module 33 is pressed to, and closely contacts the inside of the upper outer shell 13A and the inside of the heat release surface 13a of the lower outer shell 13B, due to an elastic force of the buffer member 35 provided between the low-temperature end surface 33b of the thermoelectric conversion module 33 and the heat release surface 13a of the outer cylinder 11. In the exhaust heat power generation apparatus thus configured, the inner shell 19 with a flat ellipsoidal shape is housed in the outer cylinder 11 that includes the upper outer shell 13A and the lower outer shell 13B in a manner such that

there is a space between the inner shell 19 and the outer cylinder 11. The exhaust gas G flows into the inner shell 19 from the exhaust pipe. The thermoelectric conversion module 33 is disposed between the heat collection surface 19a of the inner shell 19 and the heat release surface 13a of the outer cylinder 11 in a manner such that the high-temperature end surface 33a closely contacts the heat collection surface 19a, the low-temperature end surface 33b closely contacts the inside of the heat release surface 13a, and the buffer member 35 is provided between the low-temperature end surface 33b and the heat release surface 13a. The heat collection fin 21 is provided in parallel with the longitudinal direction (x-axis direction) of the heat collection fin 21. The heat collection fin 21 includes a plurality of plate bodies 21a and 21b with different heights in a cross section (y-z cross section) in a long diameter direction (z-axis direction) orthogonal to a direction in which the exhaust gas G flows, i.e., a long axial direction (x-axis direction). Therefore, it is possible to improve the efficiency of heat transfer from the exhaust gas G flowing into the inner shell 19 to the high-temperature end surface 33a of the thermoelectric conversion module 33. Thus, it is possible to reliably apply a large temperature gradient to the thermoelectric conversion module 33, and to greatly improve the thermoelectric conversion efficiency, as compared to a conventional case.

[0063] Further, in the invention, the heat collection fin 21 and the inner shell 19 are manufactured using stainless steel plate. However, other metals with high heat conductivity may be used depending on the temperature or components of the used exhaust gas. For example, copper, brass, aluminum, aluminum alloy, iron, iron alloy, carbon steel, inconel, hastelloy, or monel may be used. Also, a layer made of another metal or a ceramic layer may be formed on a part of, or the entire of the inner surface of the heat collection fin 21 or the inner shell 19, to increase the surface area of the metal, to improve the durability, to improve the heat conductivity, or to suppress heat deformation.